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Commercial Competitiveness for Small and Large North American Shipyards

Seattle, Washington
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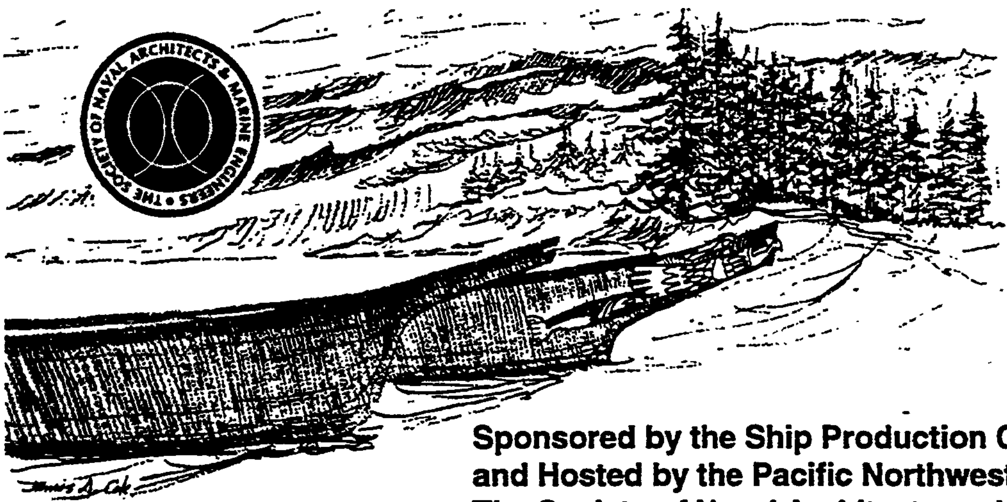
January 25-27,1995



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Marketing Strategy for Merchant Shipbuilders

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ABSTRACT

Much has been published over the years about technology and productivity in shipbuilding, and much also about the shipbuilding market and its potential. Little has been published to-date however, about the all important techno-economic interface between the two.

This papar sets out to explore this interface, and to identify how a shipyard can be matched to its external environment through the adoption of a coherent strategy. The elements of external forces are considered (in particular prices and market volume), and the internal factors within the control of a shipyard are examined to review how they can be utilized in a strategic sense to match a shipyard to a targeted market sector.

The elements reviewed include

- Prices,
- Exchange rates,
- Physical constraints,
- Capacity
- Market volume,
- Production characteristics and
- Shipyard organization.

INTRODUCTION

"Consumption is the sole end and purpose of all production and the interests of the product ought to be attended to, only so far as it may be necessary for promoting that of the consumer."

(Adam Smith "The Wealth of Nations" - 1776).

Over the past decades, much effort and expenditure has been directed at performance improvement in shipyards, with the aim of reducing costs. This has particularly been the case in higher cost countries with shipyards seeking to offset wage rests against productivity.

Performance is about much more than just productivity, however. Whilst the number of manhours used per ton produced is of course vitally important there are other factors that have a considerable bearing on a shipyard's bottom line, some of which are outside the shipyard's control.

These factors are put into context by examining the relationship between a shipyard and its marketing environment. Whilst numerous papars have been written about performance within a shipyard and about the market outside, few have addressed the all important techno-economic interface between the two.

The marketing environment within which a shipyard operates includes internal factors, generally within the control of the shipyard, and external factors outside the control of the shipyard. The internal factors that can be manipulated to cope with changes in the external environment are normally termed the 'Marketing Mix' (Lancaster and Massingham, 1988). Generally grouped under the four 'Ps', these factors are:

- the design and attributes of the <u>Product</u> to match customer requirement:
- the design and attributes of the <u>place</u> in which production takes place, encompassing not only production attributes

but also organization and in particular overheads.

- the Promotion of the product being offered, i.e., advertising or other channels to draw the product to the attention of potential customers; and

- the Price at which the product is offered, although as Will be demonstrated later, this aspect is largely outside the control of merchant shipbuilders.

The external factors affecting the shipyard, over which it has little or no control, are numerous and wide ranging, including politics and macro-economics. The more tangible factors in the immediate environment of the shipyard (termed the "proximate macro-environment" in marketing jargon), on which most marketing strategies will concentrate, include the following:

- Market Price,
- Competition,
- Wage Rates and Costs,
- Exchange Rates, and
- Demand.

When considering these factors it should be kept in mind that the external environment presents not only the threats against which a company has to react, but also the opportunities of which it can take advantage.

It is important to understand the way in which a shipyard interacts with its environment, as well as the elements of strategy available to a shipyard in seeking to match the attributes of the market. Decisions relating to production must take into account a global strategy, including reference to the external environment and not simply be based on a continuous drive to minimize manhours.

HISTORICAL BACKGROUND

For much of the past 10 to 15 years, commercial shipbuilding has not presented an economic opportunity for most of the world's shipbuilders, however productive they might be. The market collapsed following a peak of newbuilding in the mid 1970s, and has remained at a low level for more than a decade, as shown in Figure 1.

The depressed level of capacity utilization

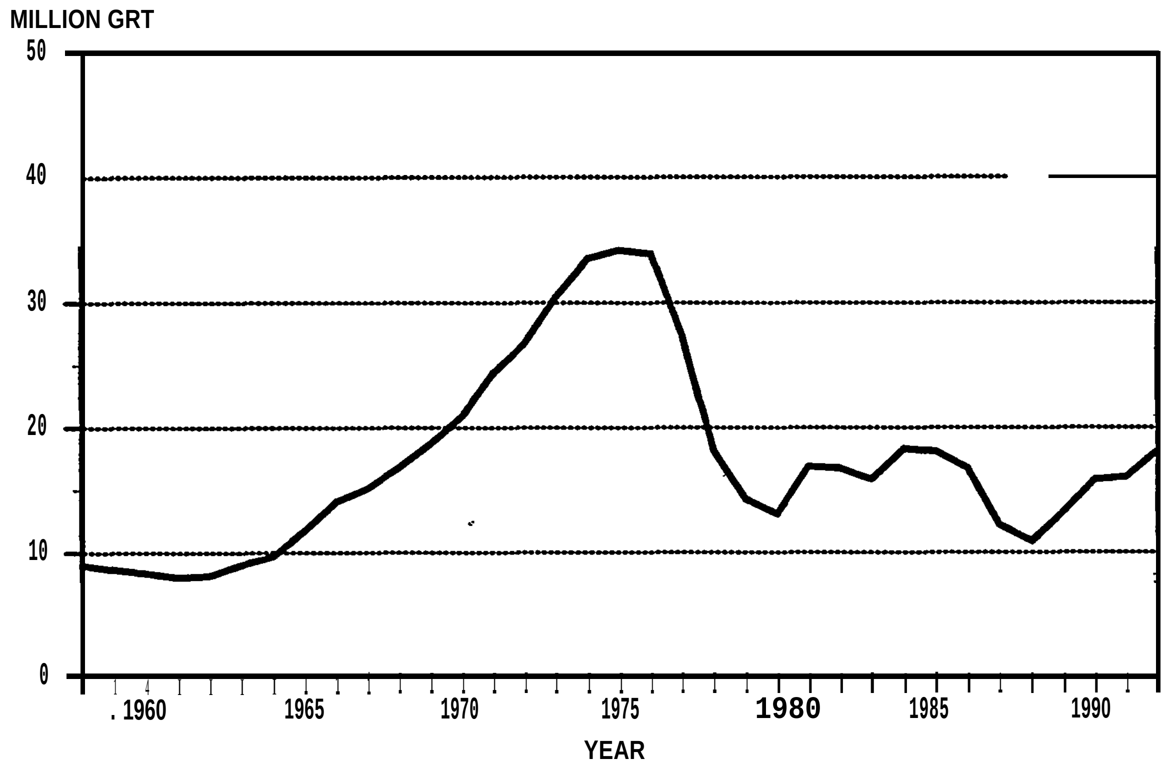
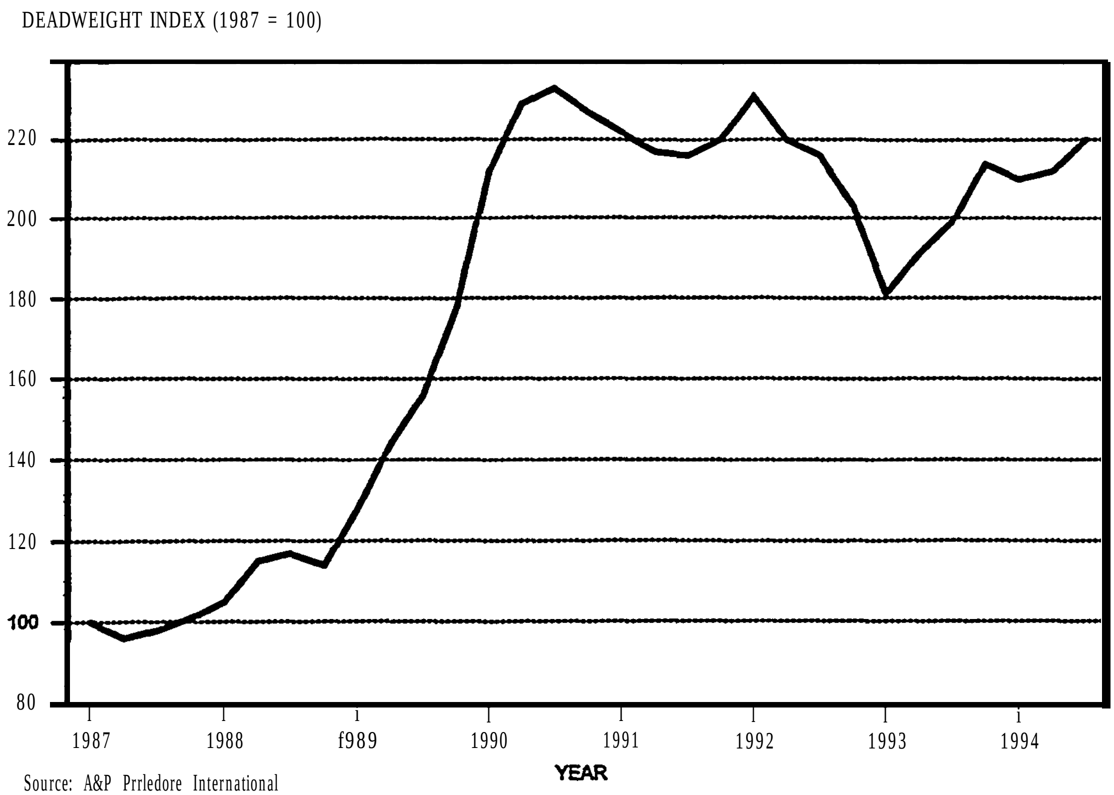
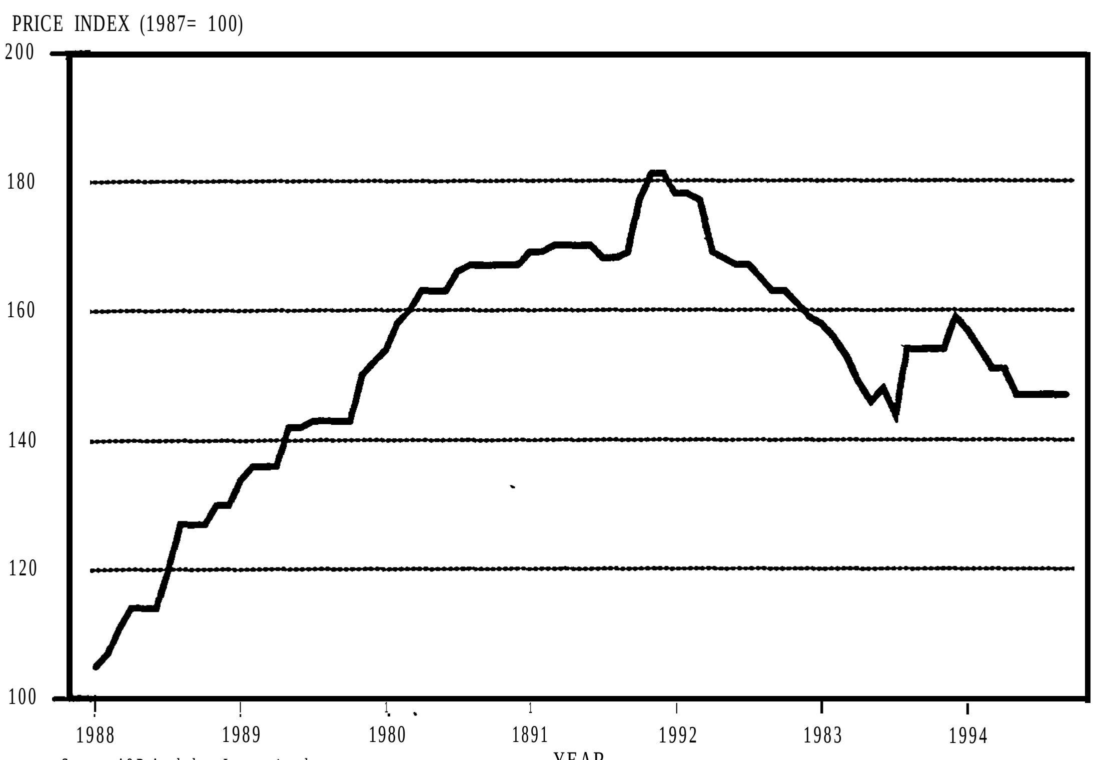


Figure 1: Merchant Ships Completed



Source: A&P Prrledore International

Figure 2: Orderbook Deadweight index



Source: A&P Applodore International

Figure **3: Newbuilding Price Index**

during this period, with correspondingly low prices, led to the closure of numerous shipyards (or in some cases entire national industries), with those shipyards remaining requiring government support and intervention to surive.

Since around 1987, however, the level of international ordering has picked up, with corresponding improvements in capacity utilization and prices. (Figure 2 presents the growth in orders since 1987 and Figure 3 the development of prices over the same period). Following the period of extended restructuring and rationalization, the industry is well placed to absorb this increase in demand without the massive degree of over-capacity seen at the start of the last decade. Having said this, prices have yet to rise to a point such that much of the world's shipbuilding industry can reliably generate a profit and subsidies are still common practice in many countries.

Demand for new vessels is generated primarily by the need to replace obsolete, aged tonnage, which has reached the end of its economic life, and by the need for the fleet to expand to accommodate growth in trade. In addtion to these two primary determinants, demand for new vessels is also generated by technical developments, such as the development of containerization, or by legislative pressure, such as the implementation of OPA90 in the USA which discriminates against aging, single skin tankers.

These factors are illustrated in Figure 4, which presents a simplified diagram of the shipbuilding market and the shipping market (Note The second hand sector of the shipping market has deliberately been left out of this diagram for the sake of clarity. For a full description of the economics of the shipping trades, the reader is referred to Stopford, 1988).

As a consequence of the lack of newbuilding between the mid 1970's and the late 1980's, the average age of the fleet is high, at around 17 years. In the face of an economic life expectancy of between 20 and 25 years, the prospects for fleet replacement in the coming decade are good, paticularty when coupled to escalating concerns amongst governments, charterers, insurers and classification societies about the large volume of aging and sub-standad tonnage currently trading. A second consequence of the historic lack of newbuilding has been that much scrapped tonnage has not been replaced and the level of surplus tonnage within the fleet and thereby its ability to absorb fluctuations in demand, has been reduced and growth in trade therefore leads more directiy to demand for new tonnage.

Against this background, most forecasts of newbuilding for the comming decade are optimistic and shipbuilders are gearing up for improved demand, although it has to be said that there are structural problems in all sectors of the market that could cast a shadow over the awaited recovery. These factors are discussed in full in Peters, 1993. This potential opportunity has arisen at a time when many shipyards are looking for opportunities to replace declining workloads for warships, following the so-called "peace dividend".

This is the situation to a large extent in the United States. Most US shipyards have not been active in the international commercial sector for

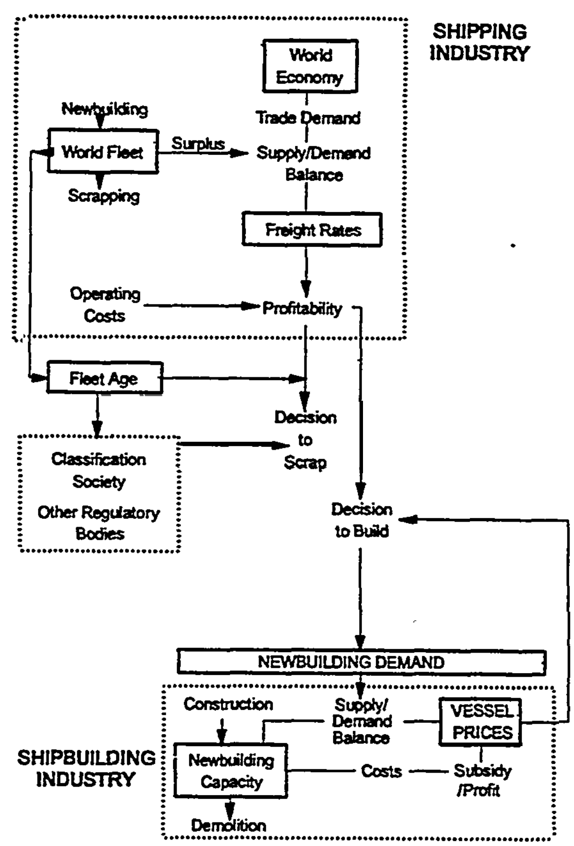


Figure 4: Market Drivers and Key Determinants

some years, and are currently seeking ways to captilize on the potential for commercial newbuilding.

In reality, a shipyard does not operate in isolation and does not have a free hand to construct whatever it chooses. The environment. (in the broad sense of the word) imposes constraints within which a shipyard must operate and which will dictate at least partially the range of ships that may be included in in product mix.

THE CORRECT STRATEGY?

When faced with a blank order book a shipyard must make a decision as to the market sector to be targeted. This decision has often in the past been made intuitively, due to lack of defined methods or constraints against which to analyze the product mix.

Successful entry into the merchant shipbuilding sector will be a matter of strategy. The era when shipyards could aim to construct all types of vessels according to market demand has finished, and most shipbuilders now specialize. This enables organizations and facilities to be correctly matched to the target market sector. The strategy requires very careful consideration, especially because it is easy to get it wrong.

A good example of a common intuiie strategy is one that would aim to build sophisticated ships, to capitalize on high levels of technology in the high wage cost countries. This seems to be a perfectly rational approach and is one that has been adopted in the past in particular in some European shipyards but some of the underlying assumptions require careful consideration.

Firstiy, this strategy wrongly assumes that the price of a ship is related to its work content In other words, that a more sophisticated ship will attract a higher price. This is unfortunately not true, as can be seen from Table 1, comparing a sophisticated container ship with a more simple panamax tanker.

The income per unit of work as measured by compensated gross tons (Kattan and Clark, 1993), is higher for the less sophisticated, larger ship than for the container ship, despite the seemingly attractive higher price of the former smaller vessel. To be rigorous the added value rather than price should be compared to work content. After subtracting material costs, the relative numbers become $750 added value per unit of work for the tanker, and $665 for the container ship.

Ship prices move on a commodity basis, rising and falling with supply and demand, as can be seen by studying Figure 3, the price index. The price is, in general, not within the control of the shipyard.

Secondly, the strategy outlined above confuses the sophistication of the product with the sophistication of the process. A passenger ship is a good example of a sophisticated ship type that uses a high level of traditional and labor intensive shipbuilding skills. Series building of simple bulk carriers, on the other hand, permits the maximum utilization of sophisticated automated processes and robotics, making best use of advanced production technologies available in developed countries. It also minimizes labor content where labor cost is a disadvantage.

	2,500 TEU Container Ship	80,000 DWT_ Tanker
Price (February 1994)	$45 million	$44 million
Gross Tonnage	37,000	46,000
Compensated Gross Tonnage	27,750	25,300
Income per CGT	$1,621	$1,739

Table I

The most appropriate strategy may, in fact, be counter-intuitive and its derivation requires very careful thought with respect to a number of factors.

ECONOMIC INFLUENCES

The implications of price not being within the control of the shipyard requires further study. A survey of potential shipowners was undertaken recently by the author to investigate the attributes that make up a marketable design, and buyer values. The following attributes were reviewed:

- Price,
- Delivery,
- Financing,
- Minimum Crew,
- Ease of Operation,
- Ease of Maintenance,
- Speed,
- Fuel Consumption/Economy,
- Capacity,
- Efficient Cargo Handling,
- Safety,
- Design/Operational Considerations, and
- Other Factors.

Whilst many of the design attributes were seen as having a positive benefit on the marketability of a design, owners (within reason) were not willing to pay a premium above the market price to reflect performance attributes. In other words, the quality of the design of a ship may be reflected in the probability of attracting a sale, but not in the price.

The effect of fluctuating prices is compounded by another factor outside the control of the shipyard : exchange rate fluctuations. These fluctuations can have a very significant effect on the economic performance of a shipyad that is almost totally outside management control. These effects are demonstrated by the following financial calculations, considering the all important but simple gross margin calculations. (Wames, 1984).

Table II presents an example of a simple gross margin calculation, taken from an actual case

Price		$19.4 million
Labor Costs	:	$6.1 million
Material Costs	:	$10.5 million
Overheads	:	$ 1.0 million
Profit	·	$1.8 million

• Including associated overhead costs

Table II

A 5% fall in price (around $1 million) leads to a fall in proftts of over 50%, and a fall of 10% leads the shipyard into a marginal position. Conversely, a rise of 5% leads to an increase in profit of over 50% and a rise of 10% leads to more than double the profit A quick glance at Figure 3 shows that price fluctuations of this magnitude are not uncommon.

To put this into perspective, compare it to an increase of 10% in productivity on the same calculation (represented by a 10% reduction in labor rests). This leads to a reduction in 'total cost of 3% and an increase in profits of around 34%. It should be kept in mind that an improvement of 10% in productivity is not a trivial target, and is likely to require considerable expenditure of effort and possibly capital as well.

The second factor that is outside the control of a shipyard is exchange rate fluctuations.

Table Ill presents two examples, firstly, in yen with the price fixed in dollars, with the movement in exchange rate between January and December 1993, secondly, with the calculation undertaken in sterling with the price fixed in dollars, and the movement in exchange rates over the second half of 1992.

These calculations use selected exchange rates to illustrate a point. However, the effect is clear. In the case of the Japanese shipyard profit would have fallen from 9% of turnover at the start of the year to a loss of almost 3% at the year's end. Conversely, the profit at a UK yard would have risen from 9% to over 27% over the six month period shown, without any internal change in the shipyard.

The aim of presenting these simple and fairly obvious calculations is to demonstrate that external economics have a significant

Calculation 1: Price Fixed in US Dollars, costs in Yen

Price (Million $)	19.4
Exchange Rate 1	125 Jan 1993
Exchange Rate 2	110 Dec 1993
Labor Cost	763 million Yen
Material Costs	1,313 miilion Yen
Overhead Costs	125 million Yen
Total Costs :	2,201 million Yen

Profit Calculations in Million Yen

	Jan 1993	Dec 1993
Income	2,428	2,141
costs	2,201	2,201
Profit	225	(60)
Profit: Income	9.28%	-2.80%

Calculation 2: Price Fixed in US Dollars, coats in Sterling

Price (Milliion $)	19.4
Exchange Rate 1	0.52 July 1882
Exchange Rate 2	0.65 Dec 1992
Labor Coat	£3.17 million
Material Coat	£5.46 million
Overhead coat	£0.52 million
Total Costs :	£9.15 million

Profit Calculations in Million Pounds Sterling

	July1992	Dec1992
Income	10.09	12.61
coats	9.15	9.15
Profit	0.94	3.46
Profit: Income	9.30%	27.44%

Table III Effects of Exchange Rate Fluctuations

influence in shipbuilding, and can be of overriding importance.

STRATEGY, TARGET MARKETING AND PRODUCT MIX SELECTION

The dangers of coming to strategic conclusions on an intuitive basis were outlined above. To arrive at a considered and objective strategy, a number of factors have to be taken into consideration. When faced with a blank sheet of paper, and the need to define a successful product mix, constraints are required against which to set targets.

The remainder of this paper discusses a number of considerations and constraints that have to be taken into account when deriving a strategy for a target product mix, under the headings listed below

- Physical Constraints,
- Market Volume, Market Share and other Market Factors,
- Production Characteristics and Organization, and
- Other Strategic Options.

PHYSICAL CONSTRAINTS

The simplest set of constraints to consider are the physical constraints of the shipyard : length, beam, depth of water and capacity. Shipyards can be classed according to the generic ship type corresponding to the maximum size of ship that could be constructed. This is difficult to classify exactly, due to the imprecise nature of terms but corresponds very roughly to:

- Small Ships (below 5,000 dwt),
- Sub-handysize (5,000 to around 20,000 dwt),
- Handysize/Handymax (20,000 up to around 45,000 dwt),
- Panamax (60,000 to 90,000 dwt),
- Cape Size (100,000 to 170,000 dwt),
- VLCC (over 200,000 dwt).

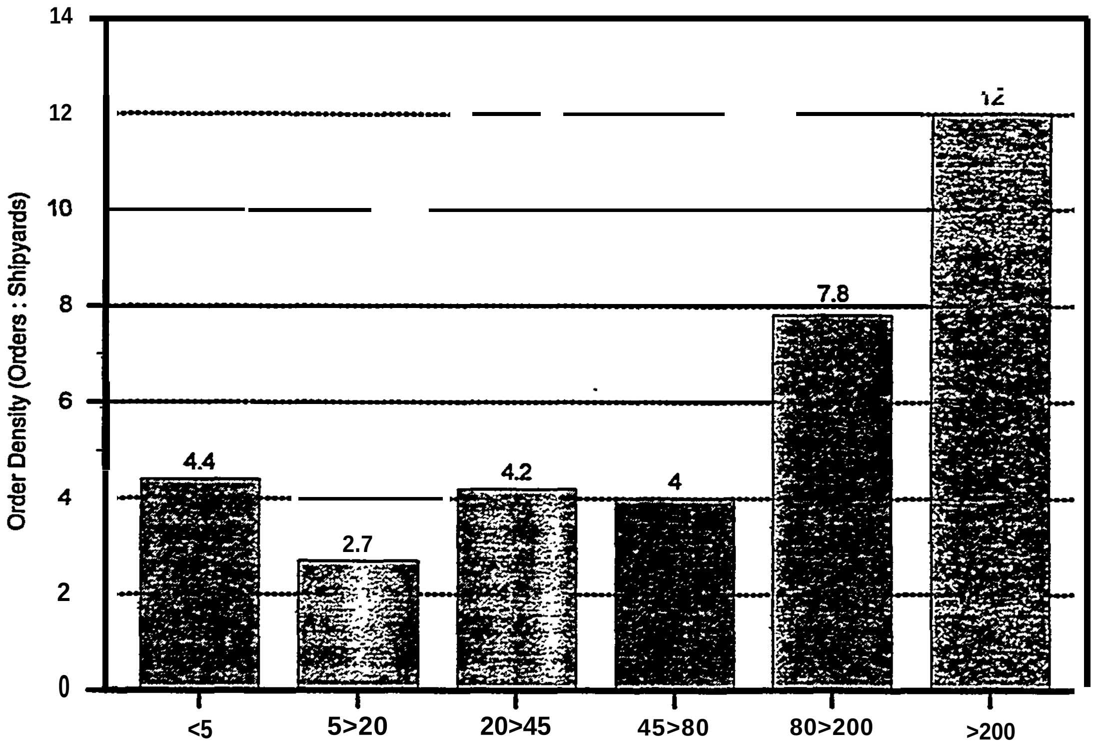
In general these size bands are very loose: only panamax and suezmax have an actual physical constraint and the generic terms are open to wide interpretation. The small ship sector is particularity difficult to classify. Below around 5,000 dwt the characteristics of the market change significantly and this sector forms a complex sub-market in its own right. (This paper concentrates predominantly on the market for larger tonnage).

All shipyards are constrained by size, although this constraint can of course be relaxed through investment, if a positive cost benefit situation is identified. In general terms, lager shipyards have an advantage. This is not

	Handymax Tanker	Panamax Tanker
Estimated Current Price*	$33 million	$42 million
Estimated CGT	15,120 tonne	22,160 tonne
Income per CGT	$2,182	$1,895

* July 1994

Table IV



Source: Fairplay Ships On Order/A&P Appledore International

DWT (000'S)

Figure 5: Order Density in the Tanker Market

because larger ships necessarily attract higher value as demonstrated by the calculation presented in Table IV comparing the income per unit of work (represented by the Compensated Gross Ton) for a handysize and a panamax tanker.

Market conditions for the handymax ship at the time of writing this paper are significantly better than in the panamax sector, so handymax ships attract a correspondingly better price.

The advantage for the larger shipyard lies in the fact that it can "trade down" to build smaller vessels, if that is what the market demands, giving an added flexibility. The smaller shipyard cannot trade up. This is illustrated in Figure 5 which considers order density in the tanker market that is the ratio of the number of ships on order in a seotor of the market to the number of shipyards participating in that sector. (These graphs are based on a sample of 1,407 tankers ordered or on order since 1989). Competition

reduces as the size of the ship increases. At the far end of the scale, i.e., VLCCs, the level of competition is much reduced, and a number of shipyards are currently anticipating the replacement of the VLCC fleet when prices could be good, due to the balance between supply and demand in this sector. Price per unit of work for a VLCC is currently around the same level as the handymax sector, but this may be adversely affected by new capacity due to come on stream in Germany, South Korea and China. This could upset the fine balance in this sector.

Thus, it can be seen from Figure 5 that, whilst market volumes are greatest in the smaller size, competitive condtions improve as size increases.

Initially the decision as to whether to relax an existing constraint in a shipyard is a fairly simple matter of economics, considering the cost and the perceived benefit However, the cost is likely to be high, and ultimately the decision must be made on the perception of the risk associated with the expenditure, in addition to simple economic calculations.

Finally, there is a need to match the physical capacity of a shipyard with the level of Workforce.

Capacuty is very difficult to specify in exact terms. It is a function of many parameters including surface area, cranage, equipment, launching arrangements and above all peop!e. The most useful measure of capacity is output (measured by compensated gross tons) per manyear worked. For example, a shipyard of 1,000 persons, operating at a reasonably productive level of output of 50 CGT produced per manyear worked, would have a capacity of 50,000 CGT per year or around 3.5 handymax bulk earners. If the shipyard has restricted berth space (particularity if it is unable to build in tandem or semi-tandem), or perhaps even more critically if it has restricted berth cranage, then launching this many ships could be a problem. Conversely, 50,000 CGT equates to roughly one 125,000m^3 LNG carrier per year, the production of which may not be constrained by the launching bottleneck.

MARKET VOLUME, MARKET SHARE AND OTHER MARKET FACTORS

It is not the intention to present here a spectic market forecast However, it is important to gauge the relative sizes of market sectors, to judge the size of the target that is being aimed at. This is illustrated in a nondimensional format in Tabie V.

TARGET MARKET VOLUMES

Shp Type	Relative Market Volume
Bulk Carrier	62.3
General cargo	53.5
Tanker	31.5
Container	21.6
Passanger (including Ferries)	17.4
Chemical Tanker	17.1
RoRo	13.9
Reefer	12.8
0B0	
LPG	1.3
LNG	1.0

Table V

The statistics in this Table are based on a recent market forecast undertaken by the author for ships between 5,000 dwt and 100,000 dwt. The smallest market sector, LNG carriers has been assigned a factor of 1. The other sectors have been assigned a factor based on the relative size of the market, For example, for every 1 LNG ship constructed, 21.6 container ships will be constructed

In terms of volume, the market can be divided into three sectors as shown in Table Vi.

Volume Markets :	Bulk Carrier General Cargo Tanker
Intermediate	Container Passenger Chemical Tanker RoRo Reefer
Niche	OBO LPG LNG

Table VI

The implications of these classifications in terms of market share are important. For the shipyard outlined above as capable of producing 50,000 CGT per annum, equating to 3.5 bulk carriers or one 125,000 m^3 LNG carrier, the implied levels of market share would be around 6% of the bulk Carrier market but well over 80% of the LNG market it follows from this that a shipyard with 2,000 workers aiming to specialize in the LNG sector would be short of work.

A strategy aiming at niche sectors has to be very carefully considered. The intermediate sector is also not without its problems. For example, 99 container ships were delivered in 1993, representing a peak of deliveries in this sector. The container ship market is forecast to improve, but not to a level significantly greater than the deliveries seen in 1993, although demand is likely to be steadier than seen in the 1980's and eariy 1990's. The caveat to this is that a new market entrant aiming a strategy in this sector is likely to have to gain market share at the expense of established specialist builders and competition Will be intense. Market entry will be diifticult Conversely, in the volume sectors of the market market share can be gained through the significant market growth that is forecast giving a greater likelihood of successful market penetration.

Finally under this heading, the characteristics of likely orders should be considered.

In the volume sector, series orders or standard ships can be expected, low cycle times leading to high throughput This leads potentially to high economic efficiency in high cost countries, with overhead or establishment costs being recovered over high throughput, minimizing unit rests.

At the other end of the spectrum, in the niche sectors, orders are more likely to be for on-offs, with long cycle times and low throughput In some cases, an entire company overhead may have to be recovered against a single vessel, or even less than one vessel if the cycle time is greater than one year. This is considered further in the following section.

PRODUCTION CHARACTERISTICS AND ORGANIZATION

Production characteristics vary significantly depending on the target market sector. This is best illustrated by considering two ships at the opposite ends of the spectrum a bulk carrier and a cruise ship. Various aspects of the production system are contrasted below for these two ship types.

Automation/Skill.

High volumes and the high level of repetitive steelwork permits maximum use of automation in the construction of bulk carriers, requiring minimum craft skill levels. Conversely, passenger ship construction is difficult to automate and relies more heavily on craft skills.

Skill Balance,

For the bulk carrier the emphasis is largely on steelwork with the reverse being the case for the passenger ship where outfit content predominates.

Throughput Characteristics.

High volume flow throughput for bulk carriers permits the use of process orientated workflow. In the case of passenger ships, the long cycle time leads to a much more product orientated flow, with the ship being the primary workstation for much of the time.

Organization.

Workstations remain largely fIxed for much of the work involved in bulk carrier production with fixed operatives. Passenger vessel are better suited to multi-discipline teams working in ad hoc workstations and zones.

Overheads.

The repetitive nature of series ship production enables overhead staff to be minimized in the case of bulk carrier production. This permits maximum economic efficiency, with low overheads recovered against high throughput. Conversely, higher numbers of planners, technical staff, QA and inspection staff, estimators, purchasers, supervisors and most

Attribute	Tanker		Cruise Vessel
Market Volume	High	← Increasing Volume	Low
Target Market Share	Low	Increasing Maket Share →	High
Order Characteristics	series	← Increasing Order Length	Unique
Cycle Time	Short	Increasing Cycle Time →	Long
Automation Potential	Maximum	Increasing Skill Level →	Minimum
Skill Balance	Steel Trades	Increasing Outfit content →	Outfit Trades
Throughput	High Volume	← Increasing Throughput Volume	Low Volume
Overheads	Low	Increasing Overhead Costs →	Higher
Potential For High Economic Efficiency	High	Increasing Unit Cost →	Low
Prduction Organization	Defined Flow Lanes	← Increasing Fixed Workstations	Ship Orientated

Figure 6: Comparison of the Attributes of Volume and Niche Market Building

other overhead categories are required for passenger ship production.

The above factors are summarized, along with the market elements, in Figure 6. This figure demonstrates that production facilities must be matched to the target product mix. It would clearly not be efficient to construct a bulk carrier in a passenger ship facility, or vice versa, although technically it could be done. This is the reason why shipyards can no longer be all things to all shipowners, as they were 30 years ago, and that most successful shipyards today specialize in selected target areas. The target that most closely matches warship construction for those shipyards attempting to convert, is cruise ship construction. It should be clear from the above that attempting to build volume ship types efficiently in a former warship shipyard is likely to be difficult without investment and possibly downsizing, in particular of overhead staff.

Mixing non-compatible ship types, such as bulk carriers and passenger ships, in the same facility should be technically and economically feasible, but would require very careful thought and planning. In particular, the allocation of overheads would have to be carefully considered so as not jeopardize the economic viability of the more simple ship types.

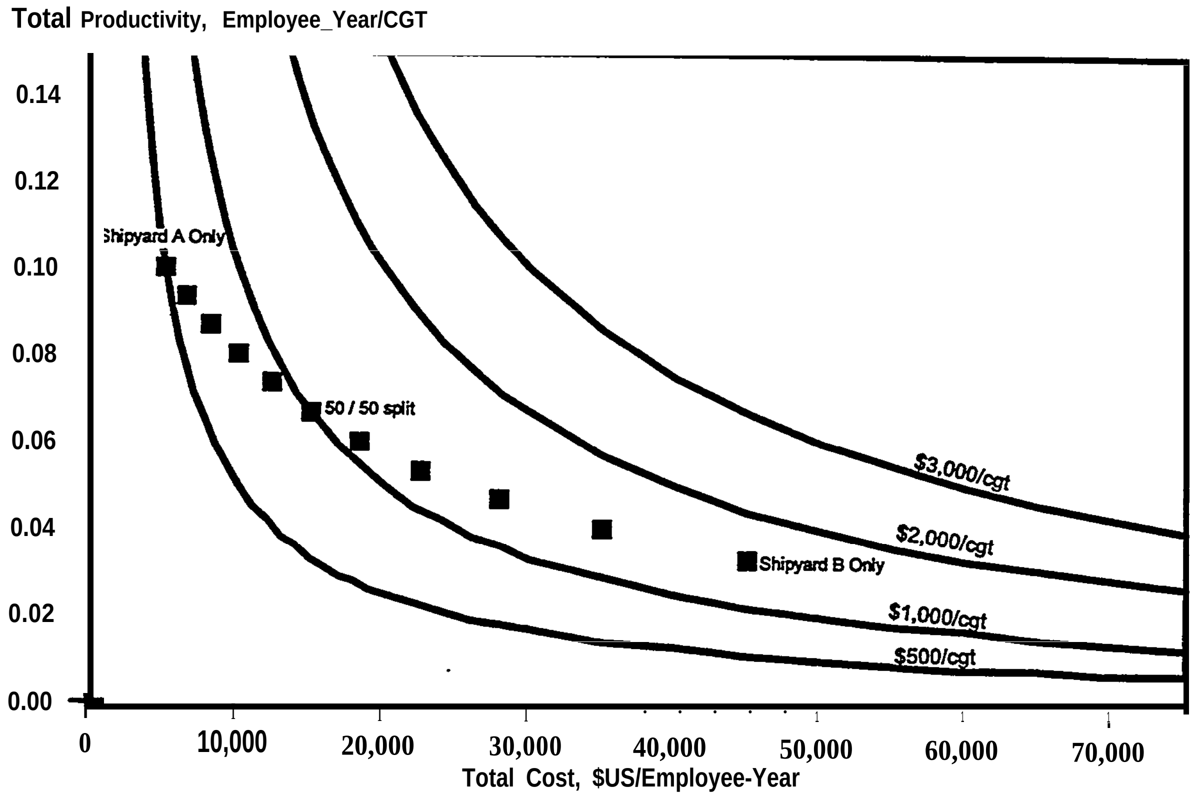


Figure 7: Combined Series Order Effect On Competitiveness

OTHER STRATEGIES : ORDER SHARING

In addition to target marketing and the matching of facilities and organization to the chosen product mix, there are other options that could be utilized as part of an overall strategy.

As an example, the following calculations concern a strategy of combining a series order in two shipyards at different levels of competitiveness. The measure of competitiveness utiliied is cost per unit of output the unit of output used being the Compensated Gross Ton.

Consider the case of a reasonably competitive shipyard in a high mat country, that proposes to. form an association with a less efficient shipyard in a low cost country, with the aim of reducing unit costs of a series order built jointly in the two shipyards. This is illustrated in Figure 7.

Figure 7 is based on curves of constant cost per unit of output (Kattan and Clark 1993), taking into account total cost per employee (horizontal axis) and productivity (vertical axis) measured by employee years used per Compensated Gross Ton produced. Total cost includes labor costs and overhead costs, but excludes material rests and other contract costs such as builder's risk insurance or financing charges. The product of the two parameters gives a measure of competitiveness cost per CGT produced.

Shipyard A is typical of a developing country, with low productivity, but a very low operating cost, giving a level of competitiveness of $500 per CGT.

Shipyard B is typical of an average level in Europe with a reasonable level of productivity but a fairly high cost giving a level of competitiveness of $1,500 per CGT.

The components of these costs are presented in Table VII.

Shipyard A:	Productivity :	0.1" rnanyeera per CGT
	Cost per manyear	S5,000
	Performance :	S500 per CGT
shipyard B	Productivity :	O.O33 manyears per CGT
	Cost per manyear	S45,000
	Perfrormance :	$1,500 per CGT

* an output of 10 CGT per manyear worked
* an output of 30 CGT 30 CGT per manyear worked

Table VII

Share of Order (ShlPyard A : B) A	B	combined cost per CGT	% Improvement unit Costa
0	100	1,500	0
10	90	1,400	6.67
20	80	1,300	13.33
30	70	1,200	20
40	60	1,100	26.67
50	50	1,000	33.33
60	40	900	40
70	30	800	46.67
80	20	700	53.33
90	10	600	60
100	0	500	66.67

Table WI: Combined Series Order Effect on ComPetitiveness

Table VIII presents the combined level of competitiveness depending on the proportion of the order placed in either shipyard and the percentage reduction in cost per unit output from the situation in Shipyard B alone.

The validity of this strategy is clear from this Table. Significant reductions in cost per unit output are possible via this course of action, without any improvement in productivity in the higher cost shipyard. A 50:50 split of the order would lead to a reduction in unit costs of one-third.

The aim of presenting these calculations is to show, again, that strategy is not simply a matter of looking inwards to improve those factors under the control of the shipyard. As indicated in the introduction to this paper, external factors outside the control of the shipyard produce both opportunities and threats, and creative ways must be sought to maximize the advantage from the former, and minimize the problems from the latter. Order sharing is one example of a possible strategy to do this.

CONCLUSIONS

Shipyards do not operate in isolation. They are subject to forces imposed by the external environment to which they must react The external environment provides both opportunities and threats, and the nature of the external environment must be understood to enable these to be identified and addressed.

In general, external forces are outside the control of a shipyard. In particular this comment is directed at price, which fluctuates on a commodity basis. It is one of the characteristics of the shipbuilding industry, that very large fluctuations in price have been experienced in the past and it is largely due to this variation that shipbuilding is seen as a difficult and high risk industry.

In order to survive in this difficult environment a shipyard must adopt a inherent strategy to match the facilities and organization to a tartgeted market sector. This strategy must be considered very carefully, with decisions made on a rational and scientific basis, and not on intuition.

When deriving a strategy, the follow-rig factors must be considered:

- Physical constraints : There will be a maximum size of vessel that can be constructed and a limit to capacity, although both these constraints can normally be relaxed if this is justified;

- Market factors : the capacity of a shipyard can be related to market volume for specific target sector, and the market share required to achieve reasonable throughput can be identified. These must be reviewed along with the competitive situation to identify the potential for market sector penetration; and

- Production characteristics and organization: The characteristics of a shipyard must be matched to the chosen target market sectors. At different ends of a spectrum the

characteristics are highly automated, high throughput and low overhead to higher craft skill level, low throughput and high overhead.

Finally, an example is presented of a potential strategy based on sharing orders between shipyads at different productivity levels. The aim to this strategy is to reduce unit rests without changing the internal characteristics of either shipyard.

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